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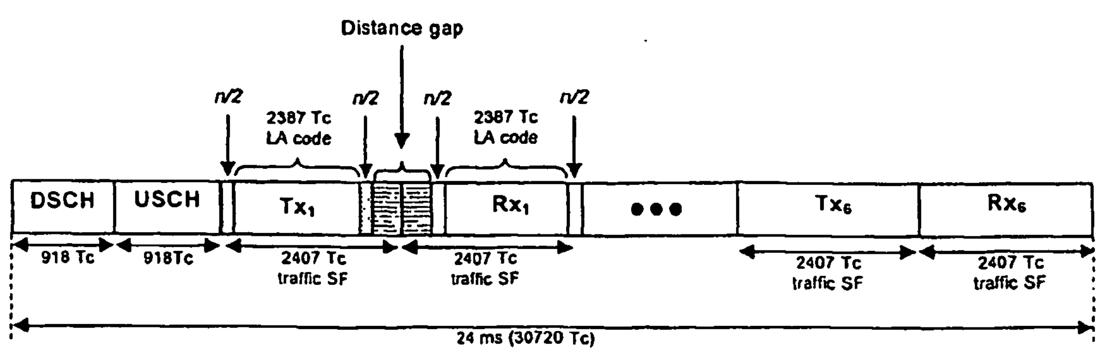

(57) Abstract: A LAS-TDD framing method for physical layer of a wireless system, in which a LAS-TDD frame comprises a downlink sync SF, an uplink sync SF and traffic SFs, the method comprising the steps of calculating the number of chips per LAS-TDD frame based on chip rates and frame length; determining the number of chips for traffic SF by subtracting the number of chips for downlink sync SF and uplink sync SF from the number of chips per LAS-TDD frame; and determining the number of traffic SFs in the LAS-TDD frame and the number of chips in each traffic SF based on the length of the LA code. With the framing method according to the present invention, a large cell coverage can be achieved without any overlapping of the transmit and receive SFs.

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A TDD framing method for a wireless system

FIELD OF THE INVENTION

The invention relates generally to wireless communication methods, and more specifically, to a framing method used in Time Division Duplex (TDD), which can provide higher capacity and performance for mobile communication services.

BACKGROUND OF THE INVENTION

Today, mobile communications are becoming one of the important factors that influence our life. It is foreseen that the future communications network will be the ″ mobile IP ″ network.

For ″ mobile “, the key is to support higher spectral efficiency and higher moving speed. For ″ IP “, the key is to support asymmetric traffic, higher throughput and smaller delay.

It is well known that the multiple access technology and the duplex technology are the key technologies for system design. From the technical viewpoint, the composite multiple access scheme FDMA/CDMA/TDMA with TDD can be capable of supporting the ″ mobile IP ″ services.

The most important aspect of a wireless technology and system is the availability of increased spectral efficiency. Most of the current Third Generation Systems are restricted in their capacity and

performance by limited spectral efficiency. In particularly, CDMA systems (e. g. WCDMA, cdma2000 and TD-SCDMA) are limited by the inherent system interference resulting from the use of the classic Walsh codes. In addition to limiting the wireless system's spectral efficiency, those codes make it challenging to design a large area TDD system. This in turn makes it impossible to leverage the benefits of a TDD system in a cellular network.

WO 99/09692, filed by Li Daoben, discloses a spread spectrum multiple access coding method, in which a coding scheme called Large Area code (LA code) is described. Figure 1 shows a LA code with 16 pulses and length of 2387 chips. The spread spectrum access code consists of basic pulses that have normalized amplitude, duration and polarity, the number of basic pulses is ascertained by such practical factors: the requested number of users, the number of usable pulse compression codes, the number of usable orthogonal carrier frequencies, system bandwidth and system maximal information rate, the intervals between these basic pulses on time axis are various, and coding just utilizes the dissimilarity of pulse positions and orders of pulses' polarities.

Large Area Synchronized Time Division Duplex (LAS-TDD) uses a new spread-spectrum technology called LAS-CDMA (Large Area Synchronized Code Division Multiple Access). LAS-CDMA is characterized by the use of a newly spreading and encoding scheme based on LA and LS codes (LAS coding) that reduce system-generated interference, thus increasing

spectral efficiency and capacity.

LA codes are defined as a varying time interval pulse series. The LA codes are used in an LAS-CDMA system to distinguish between different cells and sectors. Different permutations of the primary LA code are used in different cells and sectors of the cellular network.

Table 1 shows a primary LA code with 17 pulses with its corresponding sequence of 17 time slots with different lengths.

Time Slot	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Length of TS	136	138	140	142	144	146	148	150	152	154	156	158	160	162	164	137	172
Pulse Position	0	136	274	414	556	700	846	994	1144	1296	1450	1606	1764	1924	2086	2250	2387

Table 1 Primary LA-CDMA code

Considering a LA code with N pulses, as the order of N basic intervals has no affect on its auto-correlation and cross-correlation functions, it can be arbitrary. When a code group with various orders of basic intervals is exploited at the same time, the number of users will increase enormously.

The orthogonal characteristic or quasi-orthogonality of the LA codes can serve as a solution for reducing interference of adjacent service areas or channels.

The LA codes provide the random function necessary for multi-cell

operation and at the same time contribute to the reduction in interference between different cells and sectors.

Another benefit of the LA codes is that they allow the use of complementary orthogonal codes such as the LS codes as described in the following section (whereas scrambling methods would introduce interference between complementary components of these codes).

PCT/CN00/00028, filed by Li, Daoben with the title of "A Scheme for Spread Spectrum Multiple Address Coding with Interference Free Window", discloses complementary orthogonal codes referred to here as LS codes. The LS codes have a "Interference Free Window (IFW)" property, which is also referred to as "zero correlation window" property. For example, consider the following four LS codes of length 8:

(C1, S1) = (++−+, +−−−)

(C2, S2) = (+++−, +−++)

(C3, S3) = (−+++, −−+−)

(C4, S4) = (−+−−, −−−+)

The cross-correlation of any two of these codes is zero when the time shift between the two codes is within the (inclusive) window [−1, +1], and the auto-correlation of any of these codes is zero except when there is no time shift. Thus these four codes have a IFW of [−1, +1].

Similarly, the following LS codes of length 16 have an Interference Free Window of [−3, +3]:

(C1, S1) = (++-++++-, +---+-++)

(C2, S2) = (++-+---+, +----+--)

(C3, S3) = (+++-++-+, +-+++---)

(C4, S4) = (+++---+-, +-++-+++)

If we only consider (C1, S1) and (C2, S2), they have a Interference Free Window of [-7, +7].

Thus, when mobile stations transmit to a base station signals that are modulated using a set of LS codes that have a Interference Free Window of [-n, +n], these signals will not interfere with each other as long as they arrive at the receiving base station within n chips with respect to each other. This eliminates inter-symbol interferences and multiple access interferences when multipath signals from a same remote unit and signals from different mobile stationsarrive within an Interference Free Window.

LS codes are defined as a family of variable length complementary orthogonal codes. These codes are defined by two components – the C section and the S section – each of which are defined recursively according to a tree structure.

Besides their orthogonality, the main property of these codes is the existence of an IFW. The IFW is an area of zero-correlation in the non-cyclic cross-correlation of these codes taken two at a time. In addition, the auto-correlation function of each LS code has no sidelobes within the IFW. The length of the IFW varies according to

the pair of LS codes chosen within the tree.

A consequence of the existence of the IFW is that the interference resulting from a time-delayed collision between two transmitted symbols, spreaded by different LS codes, will be cancelled, as long as the value of the delay does not exceed the length of the IFW. Multiple Access Interference (MAI) is therefore virtually cancelled on the downlink as long as the channel's delay spread is less than the minimum value of the IFW for the LS code-set considered. Generally, since most of the received energy from other mobile station is concentrated within a few chips delay (e. g. more than 90% of the received energy corresponds to less than 5ms (i. e. less than 7 chips when the chip rate is 1.28 Mcps)), the downlink MAI in a LAS-CDMA system is reduced drastically.

On the uplink, the use of uplink synchronization ensures that all uplink signals are received within the same IFW, which means that MAI is also reduced in similar proportions..

The auto-correlation properties of the LS codes also ensure that self-interference (the interference between delayed version of the same channel, or Inter-Symbol Interference - ISI) is reduced to a minimum on both the uplink and the downlink.

By reducing the same-sector interference to a minimum, the LS codes provide the fundamental basis for an efficient wireless system.

The LAS-TDD is a multiple access system with a combination of time division and code division multiple access schemes. A physical channel

shall be described in two dimensions: time domain and code domain. Different physical channels are separated in either time domain or code domain.

In general, the behavior of traffic varies from location to location and from time to time. In locations where voice is the predominant traffic type, the traffic is more symmetrical and a frame structure with 1:1 downlink-to-uplink radio is suitable for support traffic in this location. On the other hand, in locations where web bowering is the predominant traffic type, the traffic is very asymmetrical and a frame structure with 3:1 or 4:1 downlink-to-uplink radio is suitable for support traffic in this location. Furthermore, the traffic behavior may change from time to time. In some locations, voice is the primary traffic type during the business hour and Internet may be the primary traffic type during the off peak hours. Thus, a method that allows the dynamic re-configuration of LAS-TDD frame based on traffic statistics collected at the coverage area at different times of the day is very useful in enhancing the efficiency and the capacity of the cells.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a LAS-TDD framing method for physical layer of a wireless system, which uses both spread spectrum modulation and orthogonal codes that have a zero-correlation window to provide a high capacity and high performance communications.

Another object of the present invention is to provide a LAS-TDD framing method that could reduce the Adjacent Cell Interference (ACI) among signals from neighboring base stations and the mobile stations that they serve.

The objects and advantages are achieved by the following method in accordance with the present invention.

A LAS-TDD framing method for physical layer of a wireless system, in which a LAS-TDD frame comprises a downlink sync SF, an uplink sync SF and traffic SFs, the method comprising the steps of:

calculating the number of chips per LAS-TDD frame based on chip rates and frame length;

determining the number of chips for traffic SF by subtracting the number of chips for downlink sync SF and uplink sync SF from the number of chips per LAS-TDD frame;

characterized in that

determining the number of traffic SFs in the LAS-TDD frame and the number of chips in each traffic SF based on the length of the LA code.

An advantage of the present invention is that the LAS-TDD frame can support alternating transmit and receive SF. At the same time, since each of the SF in each frame can be allocated to either uplink or downlink, it can ideally support asymmetric traffic, higher throughput and smaller delay, in other words, the ″ mobile IP ″ services. That is it allows LAS-TDD system to support different frame arrangements

dynamically depending on the system requirements.

BRIEF DESCRIPTIONS OF THE DRAWINGS

The accompanying drawings which are incorporated in and constitute a part of this specification, illustrate particular embodiments of the invention, and together with the description, serve to explain, and not restrict, the principles and advantages of the present invention.

Figure 1 shows a LA code with 16 pulses;

Figure 2 shows a frame structure of UTRA TDD defined in 3GPP specifications;

Figure 3 shows a frame structure of TD-SCDMA defined in 3GPP specifications;

Figure 4 shows the arrangement of the LS code within each time slot of the LA code;

Figure 5 shows a LAS-TDD frame with distance gap and transition gap;

Figure 6 shows a LAS-TDD frame with the downlink traffic to uplink traffic ratio of 1:1;

Figure 7 shows another LAS-TDD frame with the downlink traffic to uplink traffic ratio of 1:1;

Figure 8 shows the relative position of the transmit and receive SFs at different distances from the base station for downlink to uplink traffic ratio of 1:1;

Figure 9 shows a LAS-TDD frame with a downlink traffic to uplink

traffic ratio of 2:1;

Figure 10 shows the relative position of the transmit and receive SFs at different distance from the base station for downlink to uplink traffic ratio of 2:1;

Figure 11 shows the transmission structure for the downlink sync channel and uplink sync channel;

Figure 12 shows a frame for the downlink sync channel;

Figure 13 shows a frame for the uplink sync channel;

Figure 14 shows an example of the traffic subframe;

Figure 15 shows an example of LS Subsections of 64 chips;

Figure 16 shows a traffic subframe type 1;

Figure 17 shows the transmission of control blocks in a subframe of type 1;

Figure 18 shows a TFCI information is to be transmitted; and

Figure 19 shows a traffic subframe type 2.

DETAILED DESCRIPTIONS OF THE INVENTION

As we have known, a cellular wireless system normally comprises multiple cells that serve a geographic area, a base station in each cell providing a downlink signal to mobile stations in the cell, and a plurality of mobile stations in each cell. In such a cell, base station includes transmitters and receivers and appropriate processors. Each of mobile stations also includes a transmitter, a receiver , and

an appropriate processor.

Fig. 2 shows a frame structure of UTRA TDD defined in 3GPP specifications. Fig. 3 shows a frame structure of TD-SCDMA defined in 3GPP specifications. While the TDD frame according to the present invention can be designed to be compatible with UTRA TDD with chip rate 1.28 Mcps, which will have the similar frame structures with multiple switching points.

For CDMA TDD system design, the frame structure is one of the key factors. Some of the main concerns are capacity, coverage, flexibility, and compatibility, which will be separately interpreted herewith.

The capacity is constrained by the interferences. The consequence of these interference sources is a negative impact on system performance and capacity. Many methods have been tried and used to reduce these interferences. For example, in UTRA TDD and TD-SCDMA, Joint Detection is used to reduce ISI and MAI, and smart antenna is also used in TD-SCDMA to reduce interferences. Although these technologies can improve the system performance with the expense of system complexity, the biggest problem is that all the above interferences cannot be eliminated to the ideal level due to the drawbacks of system design.

In CDMA TDD system, the coverage is mainly determined by the gap length between transmission and reception. The larger the switching gap is, the larger the coverage will be supported. However, the gap

length is contradicted with the capacity or spectral efficiency. In UTRA TDD, the gap is so small that it is suitable for Pico-cell or micro-cell environment. In TD-SCDMA, the gap is large enough to support macro-cell environment, but it cannot efficiently support the smaller cell because the fixed gap length.

Concerning flexibility, it is highly required that flexible services can be supported in the TDD system in order to be capable for "mobile IP" applications. One common way used in TDD system is dynamic channel allocation. However, in UTRA TDD like CDMA TDD system, it is not so efficient because there will be additional interferences introduced into the system, and Joint Detection cannot work very well.

Concerning mobility, in the traditional CDMA TDD system, the fast close-loop power control cannot be achieved because the power control rate is determined by the frame length. The imperfect power control will result severe degradation for system performance. And higher speed mobility means fast channel fading, which is expected to be compensated with fast power control. Thus, it cannot support high-speed mobility. This is the case in UTRA TDD. In TD-SCDMA, another limitation for high speed mobility is because of smart antenna.

The selected orthogonal spread spectrum codes can be LS codes. And such a framing method, frame, or system that combines LA code and LS code in TDD mode will be referred to as LAS-TDD mode hereinafter.

In the LAS-TDD mode, ISI and MAI can be reduced to zero, while ACI

can be reduced to a marginal level. As long as multi-path signals from same remote unit and signals from multiple mobile stations are synchronized within a zero-correlation window, the ISI and MAI can be reduced to zero. Thus, high system performance and capacity can be ideally achieved.

Further, in LAS-TDD mode, all the signals will be kept within an IFW via bi-synchronization. Fast power control is not needed, only slow power control will be adopted to save power of mobile station. Therefore, high mobility speed can be easily achieved.

Figure 4 shows the arrangement of the LS code within each time slot of the LA code. The C and S codes of the LS code are positioned such that the gap after the C code is the same as the gap after the S code for all time slots except the last one. For the last time slot, the 4-chip gap is placed after the C code and another 4-chip gap is place after the S code. That is the gap between C code and S code of the last (16^{th}) pulse must be 4 chips.

Figure 5 shows a LAS-TDD frame with distance gap and transition gap. In Figure 5, a 24 ms LAS-TDD frame with a length of 30720 chips is given. This frame consists of a 874 chips uplink sync subframe (SF) and a 962 chips downlink sync SF. The remaining space within the frame is divided into 12 traffic SFs, each of a length of 2407 chips. In this frame, half of the SFs are used for transmission and the other half for reception. Transmit and receive SFs are organized in alternative order.

Note that in a TDD system, in order to avoid the overlapping of receive and transmit SF during the transmission path, gaps of unused chips must be inserted after the transmit SF and before the receive SF. We call this the distance gap. Further, a smaller transition gap must also be placed after receive SF and before a transmit SF to allow sufficient for the hardware to switch from a receiver to a transmitter. We call this the switching gap. A framing method for the LAS-TDD frame and allocating the gap space is described in the following.

1. Based on the required chip rate and frame length, determine the number of chips interval per LAS-TDD frame. Let the number of chips interval per LAS-TDD frame to be Tf. For chip rate equal to 1.28Mcps and 24ms frame length. Thus, Tf = 30720 Tc, where Tc is the time interval per chip.

2. Based on the required length of the uplink and downlink sync SFs, determine the number of chip interval available for transporting traffic SFs. Let Tu and Td to be the length of the uplink sync SF and the downlink sync SF respectively. The number of chip intervals available for traffic SF is Tt = Tf − Tu − Td. In the present embodiment, Tu = 918 Tc and Td =918 Tc, thus Tt = (30720-918-918)Tc=28884 Tc.

3. Based on the length of the LA code, determine the number of traffic SF that can be carried by the LAS-TDD frame. Let the length of the LA code to be Ta, the number of traffic SF per LAS-TDD frame is Nt= Tt/Ta. With reference Figure 1, the LA code with 16 pulses and length equal

to 2387 Tc. Using the LA codes shown in Figure 1, the number of traffic SFs per LAS-Tdd = 28884 Tc / 2387 Tc.

4. Based on the number of chip interval available for traffic SF Tt and the number of traffic SF per LAS-Tdd frame Nt, determine the number of chip interval allocated to each traffic SF. The number of chip interval allocated to each traffic SF is Tsf = Tt / Nt. In the present embodiment , Tsf = 28884/12 Tc = 2407 Tc.

Figure 5 shows a frame including a uplink sync SF of length of 918 chips, a downlink sync SF of 918 chips and 12 traffice SFs of length of 2407 chips.

5. For each transmit SF, position the LA code n/2 chips from the leftmost boundary of the SF. Also, allocate n/2 chips after the LA code and before the distance gap. Where n is the transition gap required after a receive SF and before a transmit SF.

6. For each receive SF, position the LA code n/2 chips from the rightmost boundary of the SF. Thus, the distance gap between the transmit SF and the receive SF can be determined as 2*(Tsf-Ta)-n.

Figure 6 shows a LAS-TDD frame with the downlink traffic to uplink traffic ratio of 1:1. The LAS-TDD frame structure has chip rate of 1.28Mcps, frame length of 24 ms, LA code length of 2387 chips and both uplink and downlink sync SF of 918 chips. The above framing method can be further optimized. With reference to Figure 4, the gap between the C and the S codes of the last time slots in the LA code can be reduced

to 4 chips. Further, the gap after the S codes of the last time slots in the LA code can be reduced to 4 chips. The remaining gap, which can be reduced, after the S code in this time slots can be combined with the distance gap to increase the length of the distance gap. That is, the remaining 28 chips can be added to the distance gap after the LA code. This significantly increases the distance gap and increase the cell radius. Figure 7 shows another LAS-TDD frame with the downlink traffic to uplink traffic ratio of 1:1. It is a equivalent diagram of Figure 6 with the enlarged distance gap.

Figure 8 shows the relative position of the transmit and receive SFs at different distances from the base station for downlink to uplink traffic ratio of 1:1. In Figure 8, the transition gap is 1 chips. Thus, 4 chips at the end of the LA code is used as the transition gap. With reference Figure 8, the 96 chips distance gap supports a cell radius of 11.25 Km without any overlapping of the transmit and receive frame. This cell radius provides a cell area of 397.6Km^2.

The above procedure can enlarge the distance gap between the transmit SF and the receive SF. Such a framing method can generate LAS-TDD frame for supporting alternating transmit and receive SFs, inwhich the uplink and downlink traffic ratio is 1:1.

For a system with asymmetric traffic load, the number of required downlink SFs is normally larger than that of uplink SFs. In such a circumstance, the distance gap should be rearranged to achieve the

maximum cell coverage.

The framing method for the LAS-TDD frame with a asymmetric traffic load is described as follows.

1. Based on the definitions as described above, the available gap space within the LAS-TDD frame is Tg= Tt-Nt*Ta, where Tt is the number of chip intervals available for traffic SF, Nt is the number of traffic SF per LAS-TDD frame, Ta is the length of the LA code. For Tt=28884 Tc, Nt = 12 and Ta = 2387 Tc, the available gap space Tg= 28884 Tc-12*2387 Tc = 240 Tc.

2. Evenly divide this gap space among the transmit-to-receive transition points. If every k downlink SF is followed by an uplink SF, the number of transmit-to-receive transition point within the frame is Nt/(k+1) and the number of chips per distance gap is (k+1) * Tg/Nt.

3. Based on the above-mentioned method, the length of the transmit SF before the distance gap and the length of the receive SF after the distance gap can be reduced. Thus, the distance gap can be increased and the cell coverage area is enlarged.

Figure 9 shows the LAS-TDD frame for supporting a downlink to uplink traffic ration of 2:1. This LAS-TDD frame is generated by the above method where the 240 chips of gap space is first evenly divided among the 4 transmit-to-receive transition points. Each transmit-to-receive transition point is allocated 60 chips of distance gap. Then, the distance gap optimization is applied such that 28 chips from the last

transmit SF before the distance gap and 28 chips from the first receive SF after the distance gap is re-assigned to the distance gap. Thus the total length of the distance gap is 60+2*28=116 chips.

Figure 10 shows the relative position of the transmit and receive SFs at different distance from the base station for downlink to uplink traffic ratio of 2:1. The transition gap is 1 chip so that 4 chips at the end of the LA code is used as the transition gap. As seen from Figure 10, 2*58 chips distance gap supports a cell area of 580.53 Km^2.

Note that the above description describes a framing method for LAS-TDD frame with a length of 24 ms. However, the present application is not limited to the 24 ms frame length and can be applied to various frame lengths. In addition, different LA code length and downlink to uplink transmission ratios can be used.

Figure 11 shows the transmission structure for the downlink sync channel and uplink sync channel. In Figure 11, x is the timing advance for the uplink synchronization.

Figure 12 shows the frame structure of the downlink sync channel. The downlink sync channel maps to downlink sync SF to transmit a sync code of a cell. Downlink sync channel assists the mobile station to perform system acquisition, downlink sync, and channel estimation.

The length of a time slot is specified in Table 2. Each time slot transmits one downlink sync burst of length 60 chips, which consists of a pair of the 20-chip C section and the 20-chip S section with a

gap of 20 chips in between. The downlink sync burst is transmitted at the beginning of each time slot.

Time Slot	0	1	2	3	4	5	6	7	8
Length (Tc)	80	82	84	86	88	90	92	94	98

Table 2 Time Slots of Downlink Sync Subframe

The sync codes may contain some system information, for example, the LAS code for D-CPICH (Downlink-Common PIlot Channel).

Figure 13 shows a frame of the uplink sync channel. The uplink sync channel is an uplink common physical channel that is used for the mobile station to transmit uplink sync signals. The codes for uplink sync channel are paired with the codes on ACPCH, and the available codes and the relation between the codes of uplink sync channel and ACPCH are broadcast on BCH.

The access burst, which consists of a 16-chip C section and a 16-chip S section with a 16-chip gap in between, is transmitted with a time offset Δ_k chips within the subframe. The C and S sections contain the C code and S code of an LS code of 32 chips, respectively. The value of the time offset Δ_k is taken from

$$\Delta_k = (k \cdot 134 + 123)T_c, \quad k = 0, 1, 2, 3, 4, 5.$$

Figure 14 shows the traffic subframe structure according to a preferred embodiment of this invention.

The length of a traffic subframe is either 2387 chips or 2359 chips.

The structure of a traffic subframe of 2387 chips, however, can be derived from the structure of the traffic subframe of 2359 chips by appending a 28-chip gap at the end. Hence, in this section, unless otherwise stated, the structure of the traffic subframe of 2359 chips shall be described.

The traffic subframe is divided into 16 time slots according to an LA code. Each time slot, having a duration of at least 136 chips, consists of a pair of the 64-chip C section and the 64-chip S section with a gap of variable length appending to each section. The length of gaps depends on the length of a time slot.

Figure 15 shows an example of LS Subsections of 64 chips. The C section and S section can be equally divided into 2, 4, 8 subsections of length 32 chips, 16 chips, 8 chips, respectively. The combination of the n^{th} C subsection and the n^{th} S subsection is called the n^{th} LS subsection. The length (in chip) of an LS subsection is defined as the sum of the lengths of C subsection and the S subsection. Thus, an LS section of 128 chips can be divided into either 2 LS subsections of 64 chips or 4 LS subsections of 32 chips or 8 LS subsections of 16 chips.

The traffic subframe is of two types: subframe type 1 and subframe type 2.

Figure 16 shows a traffic subframe type 1. The subframe type 1 can be used for downlink and uplink which includes pilot and physical layer control information. An example of subframe of type 1 consists of 4

pilot bursts, as depicted in Figure 16. The four pilot bursts are transmitted in time slots TS_0, TS_5, TS_{10}, and TS_{15}. The data bursts are transmitted in the remaining time slots. The pilot burst and data bursts are LS spread with same spreading code, but could have different spreading factors.

A subframe of type 1 may transmit two or four control blocks, which occupies an LS subsection of 64 chips each and are punctured in the second LS subsection of 64 chips of pilot bursts. If two control blocks are transmitted, they are transmitted in the second LS subsection of 64 chips of the second and third pilot bursts, i.e. time slots TS_0, TS_{10}. Figure 17 shows the transmission of control blocks in a subframe of type 1.

The transmission of control blocks in the subframe type 1 and the spreading factor applied to the control blocks are negotiated at call setup and can be re-negotiated during the call. They are indicated by higher layer signalling. The control blocks are always transmitted using the first code channel allocated in the subframe, according to the order in the higher layer allocation message.

The traffic subframe type 1 may provide the possibility for transmission of TFCI. (Transport Format Combination Indicatior) The transmission of TFCI is done in the data parts of the respective physical channel, this means TFCI and data bits are subject to the same LS spreading with the LS same code as depicted in. The TFCI information

is to be transmitted just before the second pilot burst and after the third pilot burst, as shown in Figure 18.

The transmission of TFCI is negotiated at call setup and can be re-negotiated during the call. It is indicated by higher layer signalling, which TFCI format is applied. The TFCI is always transmitted using the first subframe in a 24 ms frame and the first code channel allocated in the subframe, according to the order in the higher layer allocation message.

Figure 19 shows a traffic subframe type 2. The traffic subframe type 2 can be used for downlink and uplink which includes only data bursts. All data symbols are subject to the same LS spreading with the same LS code.

Table 3 shows the number of data symbols may be transmitted in a subframe. However, the number of binary data transmitted by a subframe depends on the spreading factor, modulation, and the number of the TFCI bits.

Spreading Factor	Modulation Symboles/Sf	
	Subframe type 1	Subframe type 2
128	12	16
64	24	32
32	48	64
16	96	128

Table 3 Number of data modulation symbols

It will be apparent to those skilled in the art that various modifications can be made to the present methods without departing from the scope and spirit of the present invention. It is intended that the present invention covers modifications and variations of the systems and methods provided they fall within the scope of the claims and their equivalents. Further, it is intended that the present invention cover present and new applications of the system and methods of the present invention.

Claims

1. A LAS-TDD framing method for physical layer of a wireless system, in which a LAS-TDD frame comprises a downlink sync SF, an uplink sync SF and traffic SFs, the method comprising the steps of:

calculating the number of chips per LAS-TDD frame based on chip rates and frame length;

determining the number of chips for traffic SF by subtracting the number of chips for downlink sync SF and uplink sync SF from the number of chips per LAS-TDD frame;

characterized in that

determining the number of traffic SFs in the LAS-TDD frame and the number of chips in each traffic SF based on the length of the LA code.

2. A method according to claim 1, characterized in that the traffic SF is a transmit SF or a receive SF.

3. A method according to claim 1 or 2, characterized in that a distance gap is inserted between the transmit SF and the receive SF.

4. A method according to claim 1 or 2, characterized in that a transition gap is inserted from the leftmost boundary of the traffic SF.

5. A method according to claim 1, 2 or 4, characterized in that a transition gap is inserted between the LA code and a distance gap.

6. A method according to claim 5, characterized in that a transition

gap is inserted from the rightmost boundary of the traffic SF.

7. A method according to claim 1, characterized in that reducing the gap between the C and S codes of the last time slot in the LA code to 4 chips.

8. A method according to claim 1 or 7, characterized in that reducing the gap after the S codes of the last time slot in the LA code to 4 chips.

9. A method according to claim 7 or 8, characterized in that adding the reduced gaps to the distance gap.

10. A method according to claim 5, characterized in that changing distance gap based on the asymmetric ratio of the receive SF and transmit SF.

11. A method according to claim 10, characterized in that reducing the length of the transmit SF before the distance gap.

12. A method according to claim 11, characterized in that reducing the length of the receive SF after the distance gap.

13. A method according to claim 1, where in the permutation position of the LA codes can be recombined, and the permutation of a time slot can be also recombined corresponding to it.

14. A method of claim 1, wherein the pulse polarity of the LA codes can be transformed, and the polarity of a time slot can be also transformed corresponding to it.

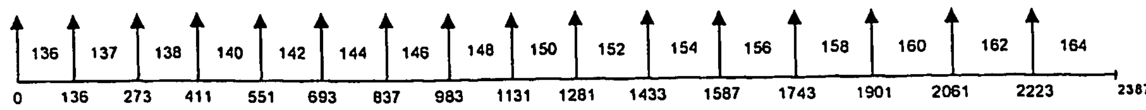

136
137
138
140
142
144
146
148
150
152
154
156
158
160
162
164
0
136
273
411
551
693
837
983
1131
1281
1433
1587
1743
1901
2061
2223
2387

FIG. 1

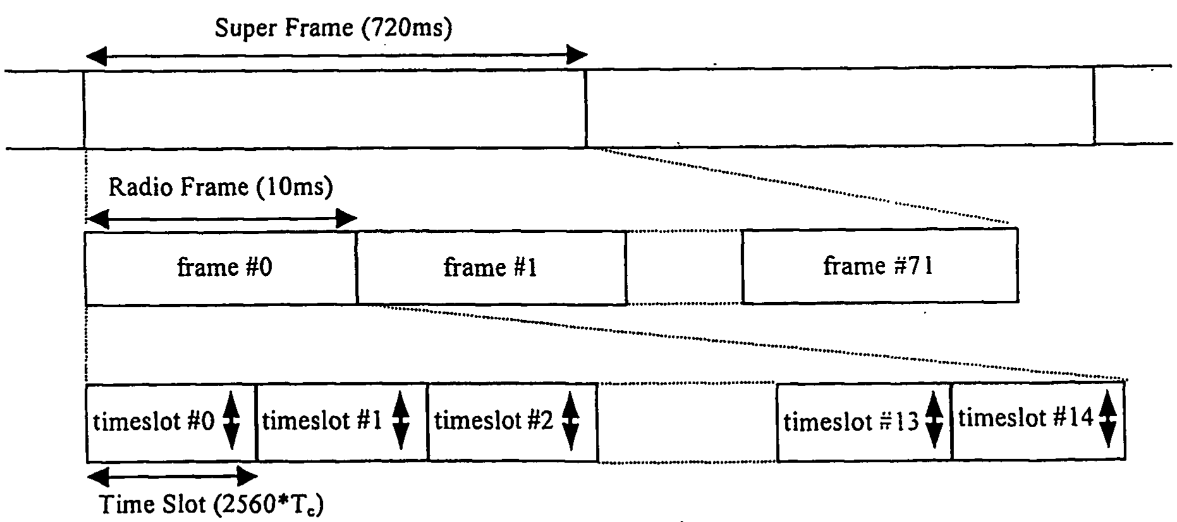

Super Frame (720ms)
Radio Frame (10ms)
frame #0
frame #1
frame #71
timeslot #0
timeslot #1
timeslot #2
timeslot #13
timeslot #14
Time Slot (2560*T_c)

FIG. 2

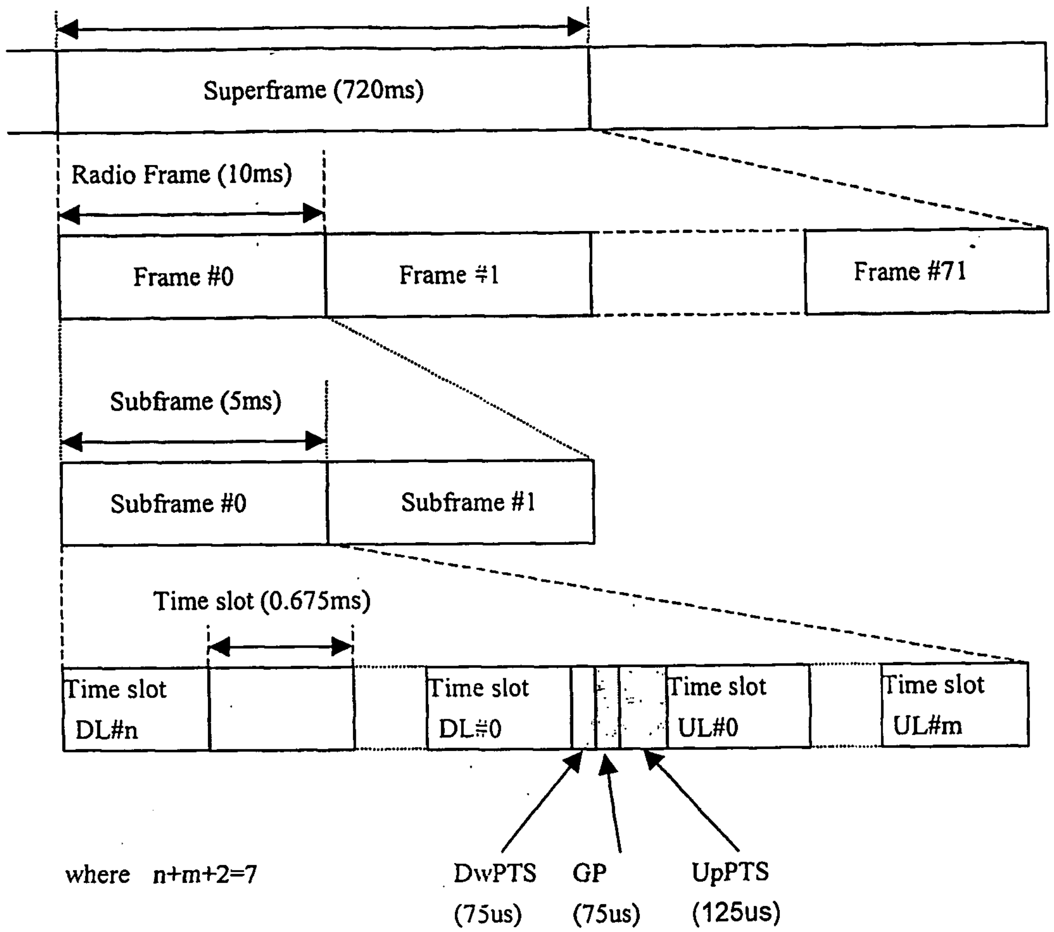
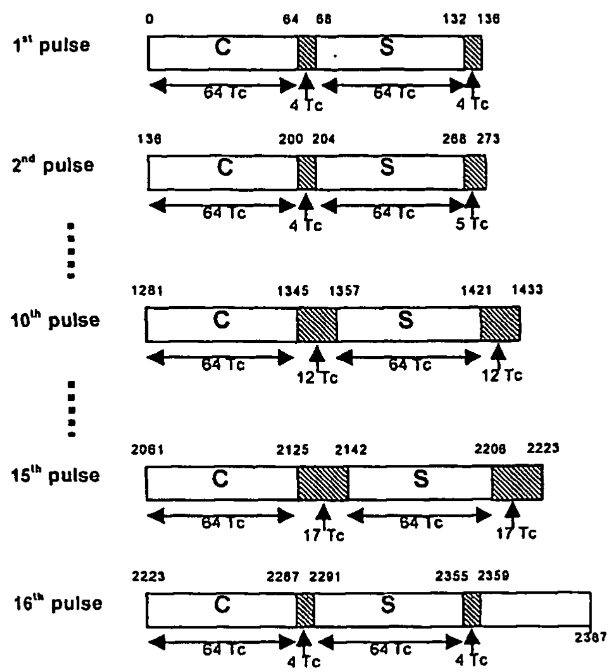

Superframe (720ms)
Radio Frame (10ms)
Frame #0
Frame #1
Frame #71
Subframe (5ms)
Subframe #0
Subframe #1
Time slot (0.675ms)
Time slot DL#n
Time slot DL#0
Time slot UL#0
Time slot UL#m
where n+m+2=7
DwPTS (75us)
GP (75us)
UpPTS (125us)

FIG. 3



• the 16 LA pulses can be permutated but the gap between C and S codes of the last (16th) pulse must be 4Tc

FIG. 4

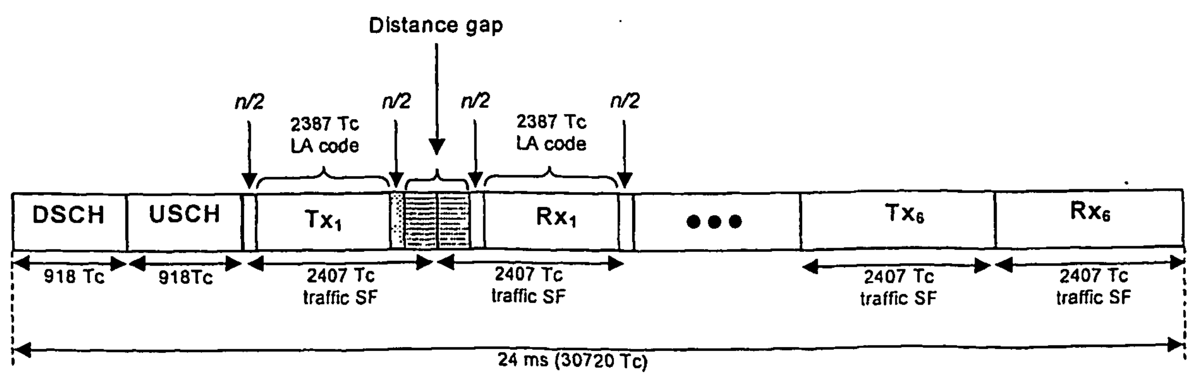


FIG. 5

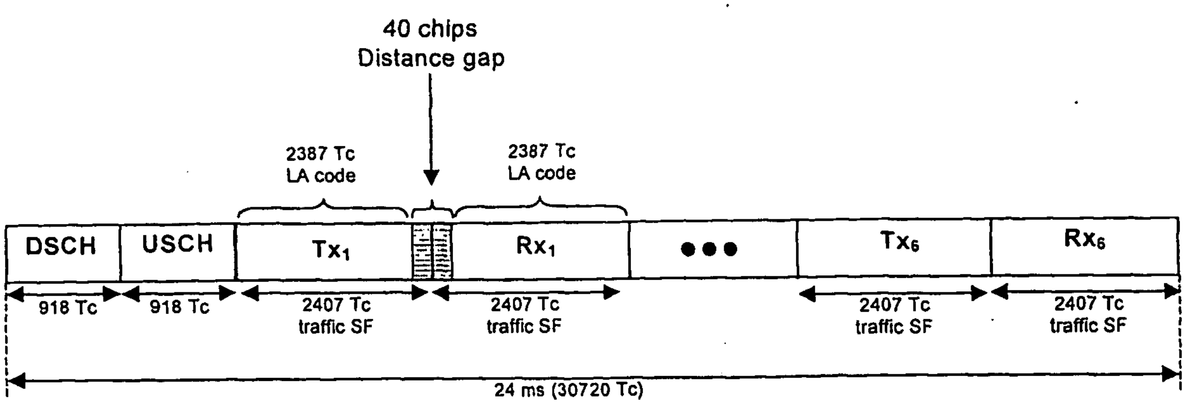

40 chips
Distance gap
2387 Tc
LA code
2387 Tc
LA code
DSCH
USCH
Tx1
Rx1
●●●
Tx6
Rx6
918 Tc
918 Tc
2407 Tc
traffic SF
2407 Tc
traffic SF
2407 Tc
traffic SF
2407 Tc
traffic SF
24 ms (30720 Tc)

FIG. 6

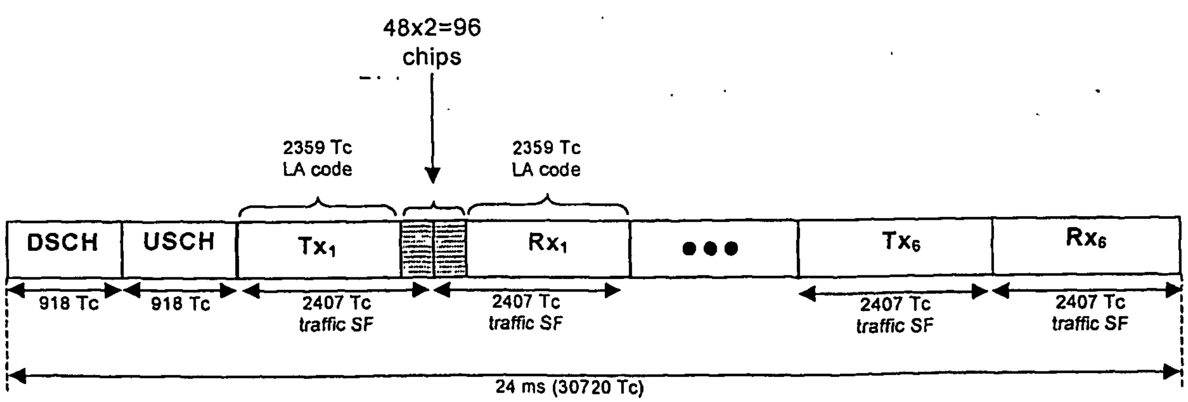
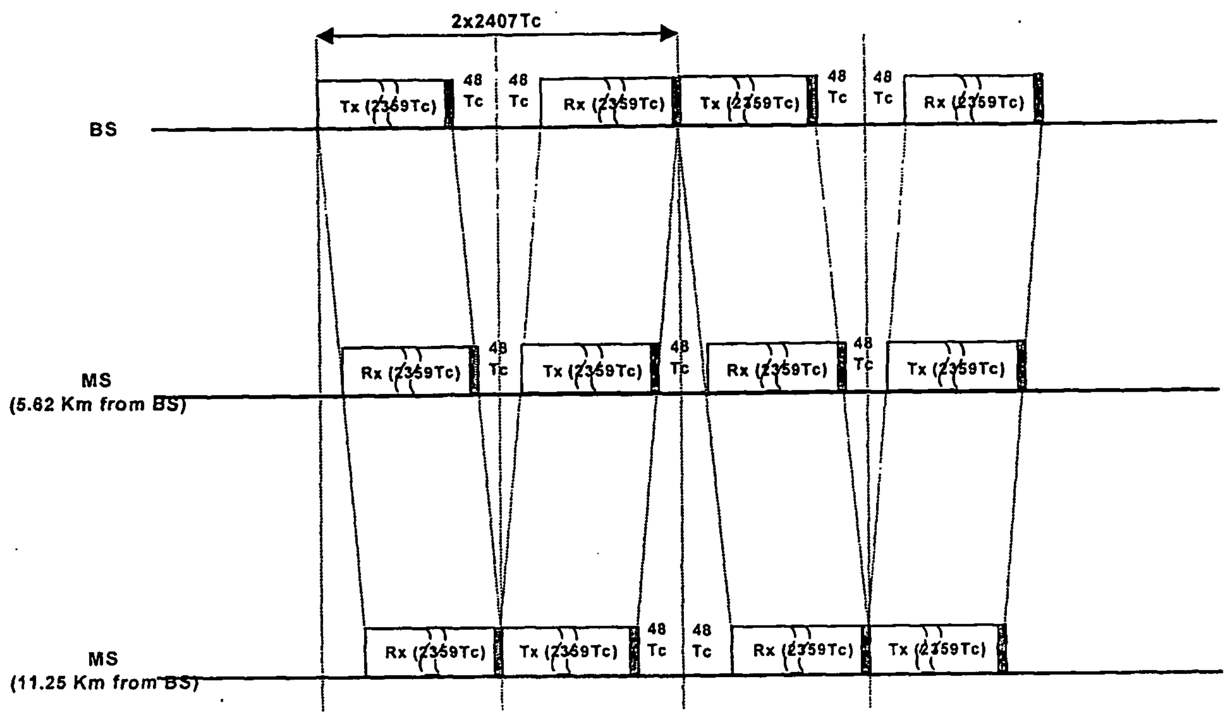

48x2=96
chips
2359 Tc
LA code
2359 Tc
LA code
DSCH
USCH
Tx1
Rx1
●●●
Tx6
Rx6
918 Tc
918 Tc
2407 Tc
traffic SF
2407 Tc
traffic SF
2407 Tc
traffic SF
2407 Tc
traffic SF
24 ms (30720 Tc)

FIG. 7



~4Tc gap inside the

Gap: 48Tc = 37.5µs

Cell range: πR^2 = 397.6 Km^2

FIG. 8

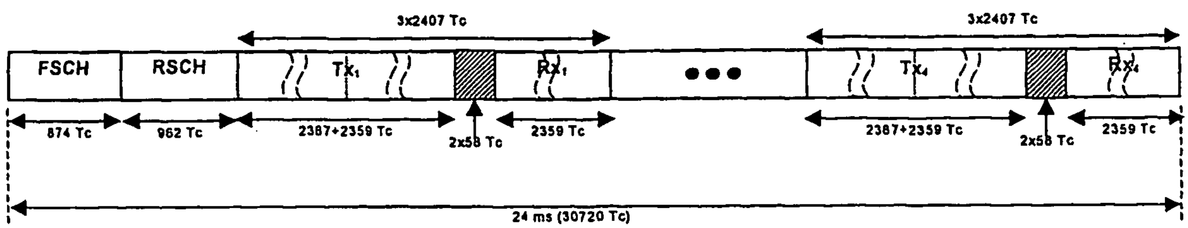

3x2407 Tc
3x2407 Tc
FSCH
RSCH
Tx_1
Rx_1
Tx_4
Rx_4
874 Tc
962 Tc
2387+2359 Tc
2x58 Tc
2359 Tc
2387+2359 Tc
2x58 Tc
2359 Tc
24 ms (30720 Tc)

FIG. 9

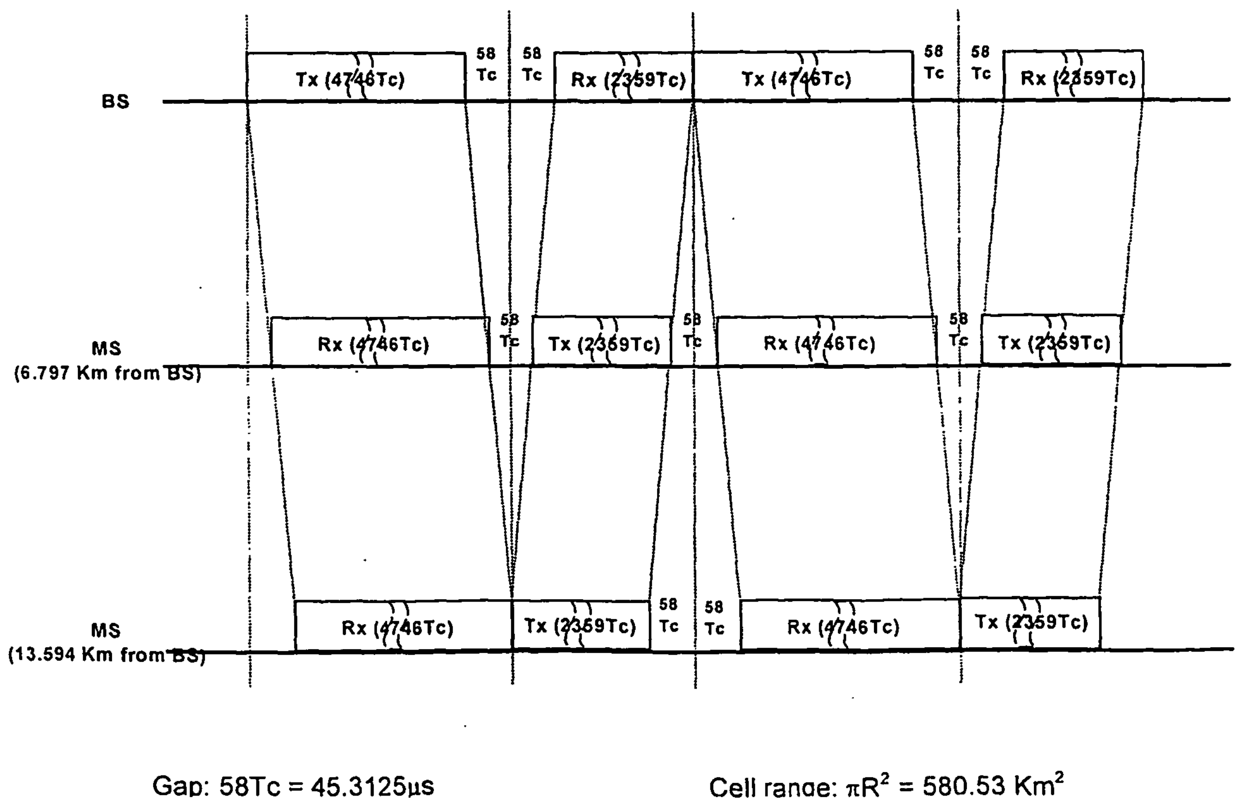

BS
Tx (4746Tc)
58 Tc
58 Tc
Rx (2359Tc)
Tx (4746Tc)
58 Tc
58 Tc
Rx (2359Tc)
MS
(6.797 Km from BS)
Rx (4746Tc)
58 Tc
Tx (2359Tc)
58 Tc
Rx (4746Tc)
58 Tc
Tx (2359Tc)
MS
(13.594 Km from BS)
Rx (4746Tc)
Tx (2359Tc)
58 Tc
58 Tc
Rx (4746Tc)
Tx (2359Tc)
Gap: 58Tc = 45.3125μs
Cell range: πR^2 = 580.53 Km^2

FIG. 10

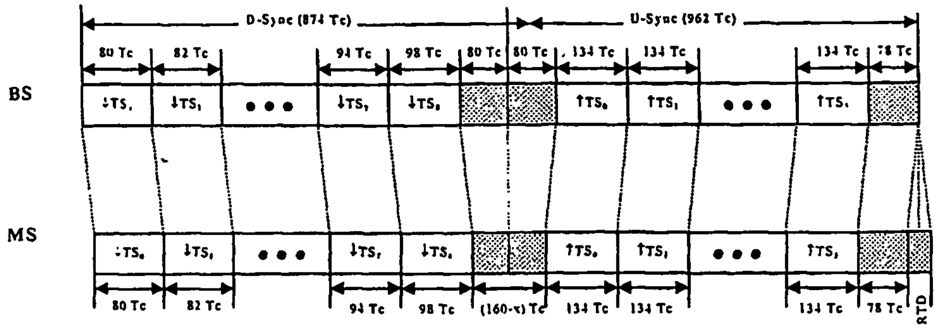

D-Sync (874 Tc)
U-Sync (962 Tc)
BS
MS
RTD

FIG. 11

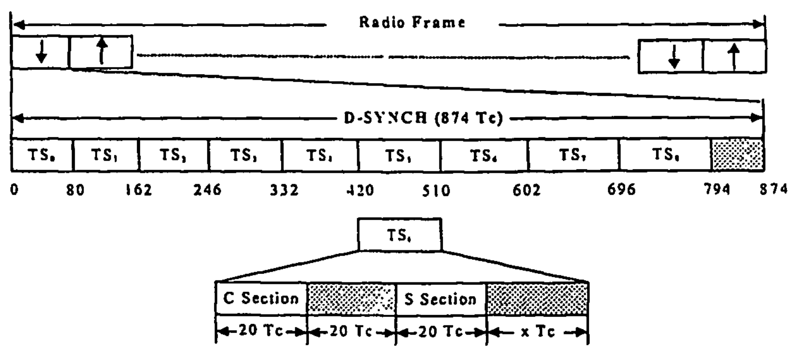

Radio Frame
D-SYNCH (874 Tc)
C Section
S Section
20 Tc
x Tc

FIG. 12

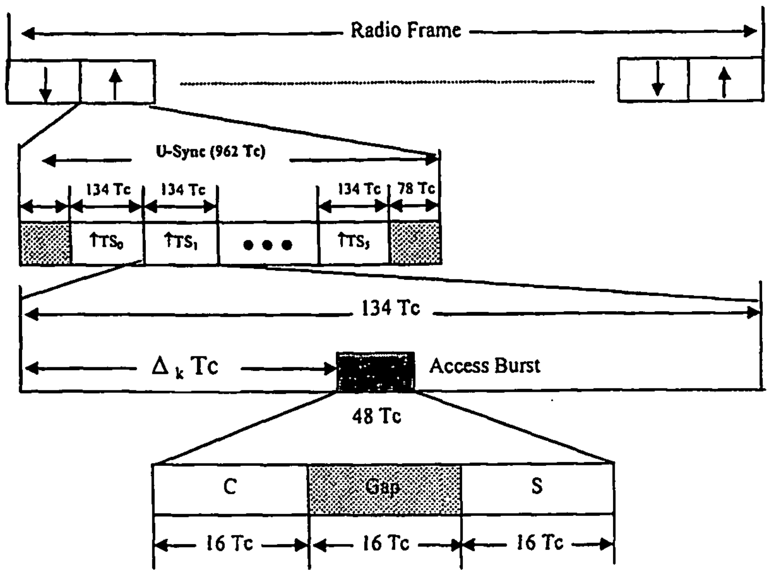

Radio Frame
U-Sync (962 Tc)
134 Tc
134 Tc
134 Tc
78 Tc
↑TS0
↑TS1
↑TS5
134 Tc
Δ k Tc
Access Burst
48 Tc
C
Gap
S
16 Tc
16 Tc
16 Tc

FIG. 13

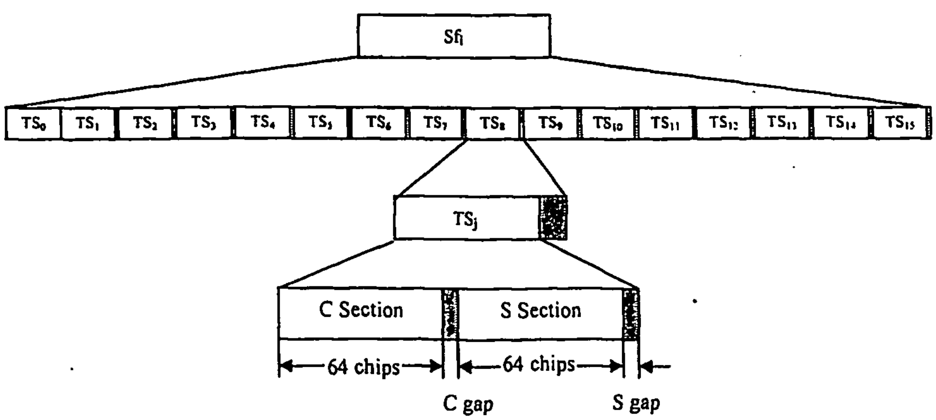

Sfi
TS0
TS1
TS2
TS3
TS4
TS5
TS6
TS7
TS8
TS9
TS10
TS11
TS12
TS13
TS14
TS15
TSj
C Section
S Section
64 chips
64 chips
C gap
S gap

FIG. 14

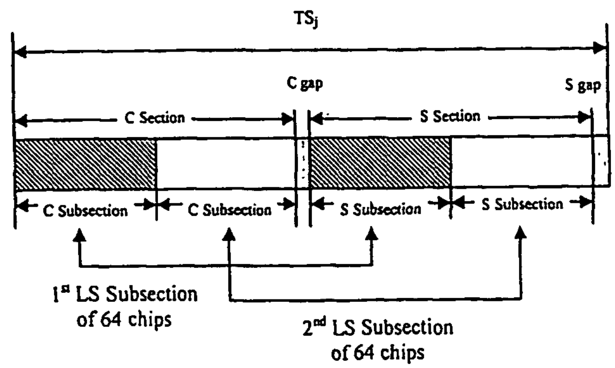


FIG. 15

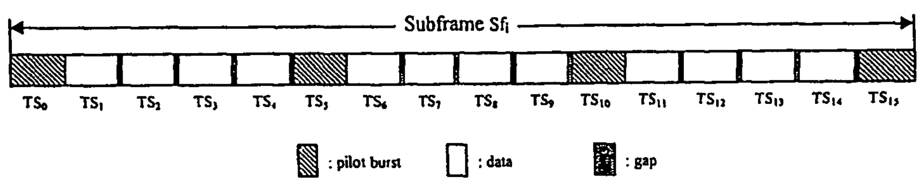


FIG. 16

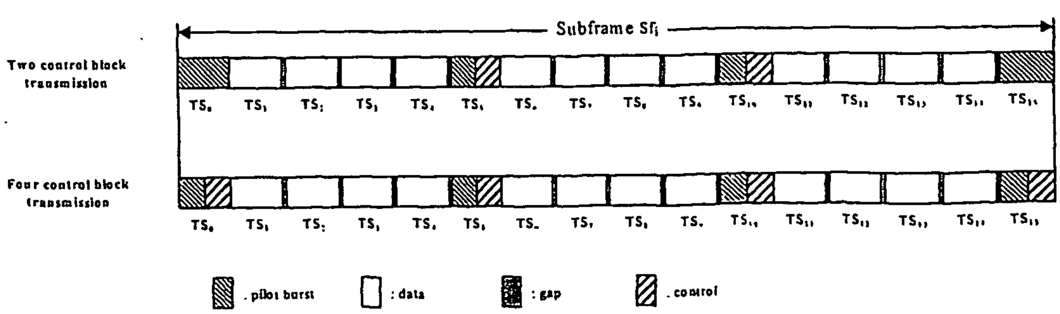


FIG. 17

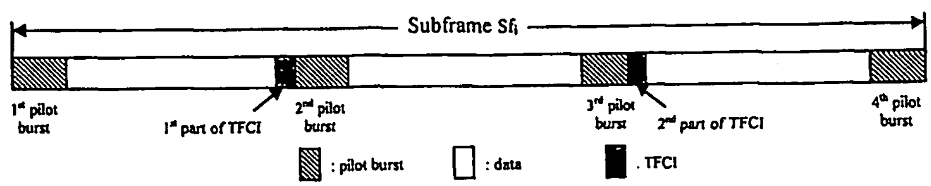

Subframe Sf_i
1st pilot burst
1st part of TFCI
2nd pilot burst
3rd pilot burst
2nd part of TFCI
4th pilot burst
: pilot burst
: data
. TFCI

FIG. 18

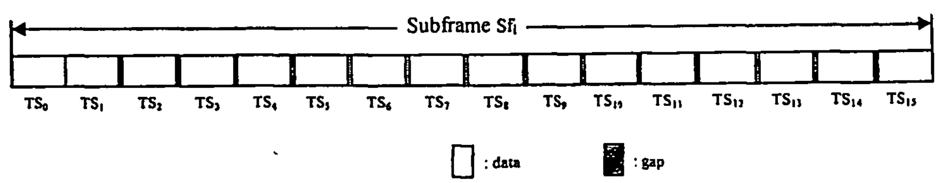

Subframe Sf_i
TS_0 TS_1 TS_2 TS_3 TS_4 TS_5 TS_6 TS_7 TS_8 TS_9 TS_{10} TS_{11} TS_{12} TS_{13} TS_{14} TS_{15}
: data
: gap

FIG. 19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN01/01175

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04J 13/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols).

IPC7: H04J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, PAJ, CNPAT: LAS-TDD CDMA communication time division duplex frame wireless system

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9909692 A1, 25 February 1999 (25. 02. 1999), whole document	1-14
A	EP 0948221 A2, 06 October 1999 (06. 10. 1999), whole document	1-14
A	CN 1219041 A, 09 June 1999 (09. 06. 1999), whole document	1-14

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search 08 January 2002 (08. 01. 02)	Date of mailing of the international search report 17. JAN. 2002 (1 7. 0 1. 0 2)
Name and mailing address of the ISA/CN 6 Xitucheng Rd., Jimen Bridge, Haidian District, 100088 Beijing, China Facsimile No. 86-10-62019451	Authorized officer CHEN Qian 印 陈谦 Telephone No. 86-10-62093356

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN01/01175

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9909692 A1	25 / 02 / 1999	CN 1175828 A	11 / 03 / 1998
		AU 8621998 A	08 / 03 / 1999
		EP 1006687 A2	07 / 06 / 2000
EP 0948221 A2	06 / 10 / 1999	JP 11261544 A	24 / 09 / 1999
		KR 99077691 A	25 / 10 / 1999
		CN 1233117 A	27 / 10 / 1999
CN 1219041 A	09 / 06 / 1999	KR 99037557 A	25 / 05 / 1999
		AU 8958698 A	01 / 07 / 1999
		JP 11215547 A	06 / 08 / 1999
		EP 0935353 A1	11 / 08 / 1999
		BR 9804047 A	14 / 12 / 1999